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Democratic decentralisation in India and the management of groundwater – An interstate analysis: 1980-2000

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ABSTRACT

The critical issue facing the groundwater aquifer today is that the rate of groundwater extraction exceeding long term recharge rate, resulting in rapidly declining groundwater levels in many areas. This paper attempts to understand the implications of democratic decentralization specifically in the context of India in resolving the problem of over-extraction of ground water. We ask whether Indian states that are decentralized with empowered local self-governments in the form of effective village councils can take meaningful steps in increasing supply and controlling demand as compared to a state that is centralized polity. In our experiment we try to explore the nature and causes of extraction. While we rely on case studies, we also use panel regression model to explain the causes of depletion for the policy suggestions as well as for forms of governance. The model is tested using 14 states from 1980 to 2000 and results indicate support for the thesis that decentralized Indian states are better at conserving groundwater than centralized states.

Key Words : Groundwater depletion, Democratic decentralization, Centralized polity, Fixed effects model, LSDV model

"If man is movement water is history, If man is a people water is the world, If man is alive water is life"
-Jose Manuel Serrat
El Hombre y el Agua

INTRODUCTION

Many Renewable Natural Resources are in general common property, exploited by many people at a time. The case of groundwater among other renewable natural resources is particularly interesting because aquifers are large in geographic scope. As a consequence, it creates two types of problem, namely, first, to establish property rights over its use and secondly, to determine the efficient rate of exploitation for the aquifer as a whole.

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As far as the first problem is concerned, while an aquifer is shared by many 'land holders' where over land rights are legally quite well defined, the share of aquifer underlying each land holding cannot be ascertained. Because of its very nature, the withdrawal of water by any land-holder results in a loss of water for the adjoining land-holder.

The limitations of property rights as discussed above makes it plausible to treat the optimal ground water exploitation management as a sole-ownership problem (Neher, 1990) and the sole owner being the (local) government. In fact, given the rate of recharge, the optimal rate of exploitation can be defined only for the entire aquifer, that is, taking all the individuals as one unit. While this problem is simple, the thorny issue that involves with this is how to enforce the optimal rate for each individual and there is no free riding. Further, unequal land-holdings may pose questions of distributional equity.

In a situation where community participation is existing, it may be simpler to monitor the use of such a resource. However, in the absence of such participation, it may be impossible to find a monitoring agency to exercise such a policy.

This paper is an attempt to analyze the major determinants of ground water exploitation in India. The critical issue facing the groundwater aquifers today is that the rate of water withdrawals exceeding the long-term recharge rate, resulting in rapidly declining groundwater levels in many areas (Dhawan, 1975, 1982, 1990, 1991). As a renewable but exhaustible resource, ground water follows a typical path of accumulation and unless a well planned exploitation is followed, aquifers will be pushed to dangerous low levels (Bhatia, 1992). The case of ground water, among other natural resources, is particularly interesting because important aquifers are large in geographic scope and its users are many. The unregulated extraction[1] rate will be 'too high' if it results in the water table drawn down 'too low', causing extraction costs to be 'too high'. Over the years, due to indiscriminate extraction of ground water in most of the states in India, water tables have been depleted to a dangerously low level in many places. Depletion of an aquifer has three chief economic effects (Neher, 1990). *First*, an aquifer can become 'extinct' through overuse if its geology is such that water channels that feed the aquifer can collapse as water table goes down and in consequence the aquifers eventually become dry. *Second*, water in the ground is "money in the bank" for use in periods of drought when local rains fail and surface water courses dry up. *Third*, it is that extraction costs rise as the water table falls[2]. Even if the social benefit of the water exceeds extraction cost, the latter will be economically excessive under an uncontrolled regime. The purpose of the aquifer management is to control these costs and optimize water use over time. Depleting ground water levels pose a threat of salinity and further it can be an environmental catastrophe as it disturbs the hydrological cycle[3].

In this context it is pertinent to ask, does democratic decentralization affect ground water depletion? Is there any reason to expect that decentralized polities/administrations manage their common property resources better than centralized ones? Specifically in the case of Indian states, are empowered Village Councils or Panchayati Raj Institutions (PRIs)

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1. The word extraction is synonymously used as harvesting, draft, withdrawal, exploitation or abstraction.
2. Also called as *User Cost.*
3. Apart from a major and reliable source for water supply, groundwater also plays an important role in moderating and modulating the surface water regime and surface eco-systems.

in a position to solve the problem of property rights when it comes to ground water with its implications on water extraction, augmenting ground water supplies and thus affecting ground water depletion? Can PRIs internalize the externalities associated with ground water to arrive at more sustainable practices? This is the question that the paper intends to answer.

The paper argues that those states of India which have a long record of practicing democratic decentralization through institutions like the PRIs which are empowered financially and to which elections have been regularly been held are better equipped to foster sustainable development practices than centralized ones. For the purposes of our study the rate of ground water depletion is a measure of the unsustainability of development. Thus this paper argues and reports that ground water depletion and the spread of PRIs are negatively linked.

It must be noted that democratic decentralization in the context of India refers less to its federal structure than to the process of constituting local self-governing bodies in those federal units themselves *i.e.*, the Constitution of District Councils, Block Councils and Village Councils and reserving some subjects that have either been the preserve of the Central and State Governments to these newly constituted bodies. This has become mandatory following the enactment of the 73rd Amendment to the Constitution of India. This is accompanied by the transfer of funds as per the rule laid out by the State in 1992. Finance Commission that every State has to set up to decide division of funds between the state government as well as the three tiers of government at the district level. At that level of empowerment, local communities are effectively constitutionally empowered.

We organize the paper in the following way: In the next Section, we review existing literature regarding groundwater management particularly in the context of India followed by a discussion as to why the process of democratic decentralization affects ground water depletion. This is followed by a series of case studies where various studies are analyzed at some length to marshal arguments that link decentralized administrations with lower rate of ground water depletion. These theoretical arguments are followed by case studies that link democratic decentralization are analyzed. We then discuss the key factors determining ground water extraction which would lay grounds for our empirical studies. This is followed by the setting up of the basic model of our regression analysis in the context of the Indian economy and a discussion of our major empirical findings. We conclude by drawing some broad conclusions and major policy suggestions for sustainable development of ground water resources.

Democratic decentralization and management of ground water resources- some theoretical arguments and case studies :

What is the economic argument for asserting that decentralization is linked to reduced ground water depletion? There are two aspects that affect groundwater depletion- the rate of groundwater augmentation (*i.e.*, supply) and the rate of groundwater extraction (*i.e.*, demand). There is a considerable body of literature that delves in to the problems of managing demand where the "commons" are concerned, but the literature on supply is thin.

The starting point when it comes to analyzing the management of common property resources is Ostrom (1990) where she spells our certain conditions that should hold if a common pool resource (such as ground water may be classified) is to be managed in a sustainable manner. These are excludability of external parties from that resource, appropriate rules for allocation and augmentation of that resource in the context of local conditions, a system of decision-making that allows stakeholders to participate, effective monitoring by agents who are either stakeholders or accountable to them, a system of penalties proportional to the degree of violation of agreed-upon norms, an affordable and accessible dispute-settlement mechanism, recognition of such community structures by the tiers of government above it and in the case of larger common-pool resources, a layered organization built upon a base of local bodies. Given these conditions, not always obtained, a common pool resource like ground water may thus be sustainably managed. The problem is that in many regions, some of these conditions may not be obtained. Given the developing world and particularly India's experience with centralized planning, no tier of the state it is thought can assure these conditions particularly when the size of the common pool resource is small. Clearly, it is not possible for a central planning authority to solve problems such as this given their complexity of the problems as well as the agents involved. Nor can the market mechanism given the obvious problem over enforceable property rights. There is no single institution that performs optimally regardless of the context or conditions obtained (Ostrom *et al.,* 2007). From this it follows that the locus of decision making should be as close to the problem as possible and should involve the immediate stakeholders. Thus a polycentric approach that evolves given the nature and magnitude of the problem is the best one as each structure involving governmental and non-governmental structures specifically evolves to solve the unique problem at hand (Ostrom, 2008).

Shah (2009) gives a comprehensive and historical view of the management of groundwater resources in the South Asian context. Echoing Ostrom (2008), he suggests that centralized mega-irrigation projects and administrations are inherently inflexible. When atomistic farmers decide when and how much to irrigate, groundwater management changes inexorably. This change has been ushered in by developments in technology which make drilling for water via cheaper pumps possible and a subsidy regime (E.g., subsidized diesel and electricity) that makes such an activity profitable. In addition to this when a milieu exists where demographic pressures force the farmer to squeeze more out of land, the State is not able to prevent the farmer from extracting groundwater. Shah argues that this is an inexorable process given the obvious attractiveness of this state of affairs over a centralized command and control system. Moreover this phenomenon has ensured that India has not experienced famine. However, as Shah points out, this phenomenon is just not sustainable.

How do policy makers achieve sustainability? As Vaux (2007, 2011) observed that even in avowedly market economies e.g. California, the State Government is heavily involved in augmenting supply or restricting demand. Similarly Community Managed Aquifer systems have had disappointing outcomes even when considering regions like Spain where such arrangements have existed for centuries. In view of these experiences, Shah calls for a heterodox approach given India's myriad conditions and one that lays stress both on Supply (through rainwater harvesting schemes etc) and demand via permits-licenses, appropriate pricing, technology, regulatory mechanisms etc. But Shah suggests that the problem in its entirety needs a degree of central planning.

Upadhyay (2005) examines the debate among policy makers and observers regarding the relative efficacy of PRIs and Water User Associations (WUA) in managing water resources. Citing case studies he argues that privileging WUAs over PRIs have come a cropper where water management is concerned. He concludes that "*without assessing the water resource, ascertaining its availability, assigning water rights and defining the institutions to administer these rights which might include WUAs as a small part of the institutional structure, WUAs are the last thing that will improve water management in the country*."

In any case as Reddy *et al.* (2006) observed in the context of Andhra Pradesh, that the Irrigation Department either does not devolve that power to the Water User Associations and/or there is "elite capture" of these institutions. They point out that the nature of demands from some Water User Associations that they should operate outside the fold of the Panchayati Raj Institutions possibly stem from the fact that under a constitutional body set up at the local level, that "institutional capture" is more difficult. Additionally, a point that is often missed is that unlike Panchayats which are constitutional bodies, WUAs are generally societies set up either under a Cooperative Societies Act or a Societies Registration Act depending on which State in India which they have been set up (Jha, 2011). Thus State level irrigation departments prefer to deal with such entities where the balance of power lies heavily in favour of the departments. Menon *et al.* (2005) report, that in the context of Kerala, WUAs are effective depending on the local level leadership and the manner in which they are able to mobilize support of key local level politicians. In fact even when water projects have not done well, the performance of the leaders of the WUA was less impressive than that of the Panchayats (Choudhary *et al.,* 2009).

The problem that India faces as enunciated by Seckler *et al.* (1999) is that continued groundwater extraction will put India agrarian economy at great risk. As Sakthivadivel (2007) points out that the number of groundwater wells in India has increased from less than 100,000 in 1960 to over 12 million in 2006. Nor can this extraction be halted given the enormous role that it plays to maintain agricultural production at its current level (Shah, 2009). Under such circumstances, India cannot wait for institutions to evolve *a la* Ostrom for this problem to be managed. The warning of Shah *et al.* (2001) notwithstanding, a certain amount of institutional leapfrogging appears necessary. Secondly, for India augmenting groundwater or supply is as important as managing it (*i.e.* demand.) It is in this context, we look State involvement through local bodies like Panchayati Raj Institutions.

The case for democratic decentralization :

If state involvement as suggested by Shah (2010) is inevitable, at what tier should this involvement be concentrated? Shah, very pertinently stresses Groundwater augmentation being as (if not more) important than Demand Management in South Asia's context. But Shah's River Basin Project calls for a certain degree of centralized planning and possibly a command and control mechanism. To be sure for centralized mega-projects involving water, the decision to create a dam or a system of dams, solely for irrigation, hydel uses or multipurpose would be the outcome of a cost benefit analysis, but projects to augment groundwater (which Shah also recommends) is far more complicated. To augment groundwater in South Asia, the accepted way is to go in for check dams and "*johads*" *i.e.*, crescent-shaped ponds along streams that recharge aquifers. While the methods chosen are simple, the basic problem that confront the supply of public goods remains- for not individual is it worth his while to invest time, effort and money in building a check dam, as the reward from that exercise will be enhanced groundwater levels which he cannot ensure will accrue only to him. Thus private cost will be less than private benefit even though the cost of the project is less than the social benefit. Thus state involvement seems to be called for as suggested by Shah. What is relevant is the nature of involvement- and it is here the case for involving local representative bodies becomes attractive.

A theoretical case for this linkage is based on grounds of economic efficiency and sustainability and may be made on the same grounds on which von Hayek (1935) defended the market economy vis-à-vis the planned economy. A centralized plan for sustainable development (in this case sustainable ground water management) is less likely to succeed than decentralized planning where the responsibility of executing this task is entrusted to the local self-governments, in the case of India to Panchayati Raj Institutions.

In so far as one of the roles of the state is to provide public goods like infrastructure where externalities are involved (ground water management certainly qualifying), a theory may be advanced. It must be recognized that most economies are not homogenous entities. There is a wide variation among various regions and localities within regions. Consequently, economic infrastructure that has to be created is not always standardized or uniform. Planning for sustainable ground water management in a non-uniform environment, especially when local economic activity is particularly affected by local factors requires the collection of relevant data - available locally - and then processing this data into information. Ideally, it should be this information that is the basis of planning for certain kinds of infrastructure. This is also true (indeed especially so) for agriculture and a host of agro-industries. To that extent infrastructure required to support that industry/economic activity in a sustainable manner will be peculiar to the locality as its nature and quantum will depend on local conditions. Thus that potion of infrastructure will be best planned, executed and managed by the members of the locality itself. The reasons are simple. The members of the locality or their representatives being first hand observers of local conditions should know the best way to create an appropriate supporting local infrastructure and should be able to do so in the most economical manner. Indeed, for projects relating to watershed management, local self-governing bodies can mobilize free labour (by suitable innovation as regards distribution of benefits) from its citizens, which in the context of South Asia usually means unutilized labour.

If, on the other hand, the central government is entrusted with the responsibility of providing all infrastructural requirements, then it has to collect information from all the localities, aggregate this information and process it to arrive at a plan to provide infrastructural support. This is obviously a monumental task and one that is not easily accomplished. Additionally, in the process of aggregating information, it is likely that some information of value will be lost. To that extent the plan created will be *faulty/sub-optimal*. Furthermore, given the magnitude of this exercise it is also likely that the *lag* between the perception of the problem and action will be larger; resulting in the possibility of the link between local public good requirement and a local solution is broken. While local demands will be aggregated, the solution that is proposed will be a centralized one. Take the case of the construction of a multi-purpose irrigation dam to cater to the needs of a large number of people spread over a large area distributed into various localities. This solution, while at times the only and perhaps the best solution, may not always be so. For *one*, the capital costs of such projects are very high. *Secondly*, they can take a long time to complete. *Thirdly*, it has a tendency to submerge the most fertile areas and thus the most populated areas and displace a section of people 'for the greater common good'. However in the absence of effective decentralization, the solution like the one above will be the only solution.

Since the provision of water for large irrigation system and multipurpose reservoirs, by and large, in the domain of the state and the central governments and logically so and the usual mode of meeting requirements on a mass scale is met by the construction of large canal systems which is beyond the capacity of local civic authorities, be it urban or rural, in contrast to the management of piped water systems, in which local authorities play a larger role. However, such projects are highly capital-intensive projects and not without their share of controversies, not the least because of doubts over their long run cost-effectiveness.

The alternative is to go in for decentralized solutions but one that depends on local participation, like roof top/rainwater harvesting to develop financial mechanisms which increase the power of local authorities to mobilize finance on a larger scale, such as through long term bonds. Given their nature they are best administered by the local civic authorities like the PRIs. If these schemes are successful, then not only are significant savings effected, the conflict between agriculture and industry over electricity can also be lessened[4].

This implies that even if WUAs are the most appropriate body, their success as brought out by Menon *et al.* (2005) will depend on the manner in which they are nested with other tiers of government. For most MUAs this will mean the Village or the Block level council. Thus what is called for is cooperation. Secondly effective leadership requires a milieu in which such leadership is incubated. It is likely that in a state where local self government has long been in existence, a polity exists where even at the local level there exists leadership that can negotiate with government departments on more even terms and arrive at consensual decision making at the level they operate in.

Democratic decentralization and sustainable development: Actual performance :

Does Democratic Decentralization actually lead to practices that are sustainable? As has been pointed out before, the literature on this subject where groundwater augmentation is concerned is not very encouraging although it must be qualified that there is not much literature that explicitly looks at democratic decentralization and ground water extraction. There is literature that looks at the effect of democratic decentralization on the nature of public investment. An example of this is Rosensweig and Foster *et al.* (2001) who report (based on a study of 250 villages in India) that the replacement of local/traditional methods of village administration with democratization has the effect of changing the nature of expenditure from irrigation projects (preferred by the rich peasants who had hitherto been *de facto* rulers through the village headman) in favour of road building (favoured by the poor as it increases employment). Expenditure on education also receives a boost. They also

4. This is because if the experience of *Tarun Bharat Sangh* (see below) is anything to go by, the rise in the water table reduces power consumed in pumping water to the fields.

report that fiscal decentralization not only boosts local governments' incomes but also lowers the cost of public investments. But the consequence for sustainable practices may not be entirely positive if employment issues remain paramount. In such cases, grants by the central and state governments to the local bodies like Village Councils may have to be tied explicitly to water augmentation schemes as Gujarat did in 2000 which is discussed later. But the ability of the local representative body to mobilize local labour and local knowledge is the key.

Some case studies :

Before we consider case studies involving the ability of Village Councils to augment groundwater, it would have to be argued that local knowledge to augment water supply given the local environment, exists. The activities of *Tarun Bharat Sangh i.e.*, the Young India Association in Rajasthan is a case in point.

Tarun Bharat Sangh :

The successes of the Tarun Bharat Sangh (TBS)[5] in Rajasthan in watershed development projects have opened the eyes of policy makers to the possibility of rainwater harvesting as a tool for ensuring the supply of water even in areas with scanty rainfall (Malin *et al.,* 2001). It is best exemplified by the experience of Alwar district that had been declared a 'Dark Zone' (No Ground Water) in the 1980s by the authorities and activities like agriculture had almost ceased to exist. It is here that the Magsaysay Award winner, Rajendra Singh, the founder of the TBS with the help of the villagers of Kaonta Bhaontala constructed the first check dam in 1985. In 1986, they constructed a *johad* (a traditional crescent shaped pond) at the source of the River Arvari which had become a seasonal rivulet. Other villages too followed suit constructing *johads* in the other catchment areas of the Arvari. When the number of ponds touched 375, the Arvari that had almost ceased to exist, revived and from 1994 became a perennially flowing river. What TBS has accomplished points to the possibility that local labour combined with very little capital and tremendous amount of traditional knowledge can bring about a remarkable economic transformation. The implications for ground water augmentation are obvious. The economic impact can be gauged for the effect of the investment made by the villagers of Neembi. On an investment of Rs. 50,000/- ($1000) to build two check dams, Neembi produces vegetables and milk worth Rs. 3 crores ($0.6 Million)[6] . This is not the kind of capital-output ratio that can be easily ignored especially by states who are financially constrained.

However ignored it was till 2000 when large areas in India were struck by drought. It was suddenly discovered that the villages under the TBS's area of operations did not suffer from want of water, even though Rajasthan was suffering from drought for three consecutive years. Indeed in some areas the ground water lay only three feet from the surface.

TBS's success must be studied carefully if it is to scaled up significantly. For the implementation of such exercises, the amount of labour required, the know-how required as well as the information of local geographical and hydro geological conditions is crucial.

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5. 'The Arvari, Coming Back to Life', *Down to Earth*, March 15, 1999
6. The figures in US Dollars are at the exchange rate of Rs.50/- a Dollar.

Briefly summed, the following seem to be the characteristics of the projects undertaken by the TBS. By and large information about the latter is extremely localized. *This would preclude the possibility of a statewide exercise/effort to undertake rainwater harvesting schemes centrally planned and implemented from a state capital*. Indeed, local participation and planning (and in this case even finances) were locally procured.

However not all state governments heeded this lesson. Indeed the government of Rajasthan attempted on number of occasions to demolish the structures that the TBS had set up failing each time in the face of determined opposition of the villagers who have benefited from this scheme. The grounds ran from legal (the state claimed that the TBS had no right to construct the check-dams) to technical (the structure of the traditionally check-dam was deemed to be unsafe.) However a group of eminent persons which included engineers disputed the state government's claim. In this din, the enormous beneficial effects of the TBS's activities relative to the modest investments made were ignored till drought struck India in 2000. Thus law and attitudes were against local empowerment even though they had proved their worth. On larger scale, the efficacy of involving local bodies especially Village Councils was demonstrated in the case outlined below.

The Power of the Panchayats- A case of two states :

In the aftermath of the drought of 2000 Prime Ministerial pronouncements that rainwater harvesting should be looked into were heard and two states decided to undertake this on a wide scale. They were Andhra Pradesh and Gujarat.

The state government of Gujarat launched the *Sardar Patel Participatory Water Conservation Programme* (SPPWCP) choosing to act through the PRIs. The state government invited proposals from the panchayats and faced an overwhelming response. Initially, the state government had budgeted for approximately 2500 check dams at the cost of Rs 100 crores ($20 Million). However the response and innovation of the PRIs in the state ensured that while the number of sanctioned dams quadrupled to 10,500 the budget only doubled to Rs 200 crores ($40 Million). Impressively enough, the state government did not bear the entire cost but asked the villagers to bear 40 per cent of the cost. Planning and execution of the project was done by the PRIs themselves. The results of the SPPWCP have been described as 'good (Prasad 2000).' While there have been cases of corruption, these have been limited. The best results have taken place in those villages where civil society was involved.

The case of Andhra Pradesh is another matter altogether (Prasad, 2000) :

The *Neeru Meeru* Scheme in Andhra Pradesh, unlike the one in Gujarat, did not rely on local participation. Here the state relied on contractors and bureaucrats and the results have been poor. Being centralised, they have fallen prey to certain members of the ruling party who utilised the scheme to set a system of patronage. This is easy, as those managing and executing the scheme do not live amongst those who are its beneficiaries. It is also clear that States that have long nurtured PRIs are also states where participatory schemes will be successful.

But that is not all. The planning for such projects which require as we have previously argued specialised and local knowledge acquired by local people over a long period of time cannot be transferred to external agents like contractors in a small period of time. Additionally what must have undoubtedly to Gujarat's success must have been the fact that 40% of the investment required had to be raised locally as per the state government's guidelines. Thus the villagers had added incentive to see that their investment was productive. The villagers in Andhra Pradesh having invested nothing themselves had less incentive. Here Garello's (2004) point about fiscal coherence becomes particularly relevant. A local government which does not have to fully or partially finance a scheme that it has to implement is likely to less concerned about the productivity of such investment than one where it is asked to share the cost. Similarly its inputs regarding information are likely to be more relevant when the project in question is thoroughly local one. Taken further we can argue that the greater is the responsibility of the local government in financing its own activities, the concerned it is likely to be regarding the productivity of the project.

Indeed, as in the case set out below, a village may even take it upon itself to finance the entire project itself.

Financing one's own plan: The case of Gandhigram[7]:

Gandhigram in Kutch, in the face of state government inaction, decided to mobilize the resources it requires to build a check dam in the year 1999. It organized Rs 15,00,000 ($30,000) loan from a Non-Resident-Indian (NRI), a Rs. 5,00,000 ($10,000) loan (at 16 per cent interest) from the *Kutch Gramin* Bank and voluntary labour from the residents would contribute an additional Rs. 7,00,000 ($14,000). The loans are to be paid back in 5 years. Each resident agreed not to irrigate more than 5 acres of land and will share in the maintenance costs. As this dam will help them to grow an additional crop, the profits from this enhanced income are expected to pay for the dam. Again the ability of the local government to encourage/enforce cooperative behaviour enables it to execute this project. State governments, who are far more remote from the villagers than the PRI representatives, will find it impossible to elicit cooperation of this magnitude and certainly not from all villages of the state. Thus, the link between decentralizing power and increasing effectiveness of expenditures on infrastructural expenditures cannot be ignored. As the capital-output ratio declines with decentralized polity, the foundations of an efficient economy as well as a sustainable development model are laid.

It is not being argued that bringing in the PRIs will necessarily enhance the state's irrigation assets. It is quite likely that PRIs being new institutions in this state will not be as dynamic as the Gujarati PRIs have been or be a Gandhigram which has planned, implemented and financed such irrigation scheme from start to finish. But to put a bar on their (PRIs) freedoms is a sub-optimal action because it precludes the possibility of a TBS like organization from taking root in the state and making rainwater harvesting a way of life. Even if such an organization arose, *such an entity* as TBS in Rajasthan *would be in the unenviable position of trying to enhance the productive capacity of the state in violation of state laws*! The possibility of one enterprising panchayat leading the way and the others following is also

7. 'Bank Loans to Harvest Water, A Community in Kutch mobilizes Resources to meet its Water Needs' *Jalvani*, vol3, no2, 2000.

discounted. In states like West Bengal observers have noted the success of enterprising panchayats and have asked their local panchayat officials why that success cannot be emulated (Ghatak *et al.,* 2000).

Thus it is clear that the link between democratic decentralization and sustainable ground water extraction cannot be dismissed out of hand. *This is because not only do empowered PRIs invest in schemes that augment supply but they are also in a position to control demand given the information that they have and the powers of persuasion that they possess that is denied to a more centralized authority*.

Sustainable practices require both demand and supply responses. In the context of South Asia where population growth rate since 1994 has been greater than growth rate of agriculture, groundwater will continue to be extracted. Thus sustainable practice must also pay heed to supply responses. As speed is also of the essence, policy makers are not likely to wait for markets or institutions to evolve to ensure sustainability, state involvement to prevent a crisis in groundwater is inevitable. If this is to be, in the Indian context the Village Council is the lowest tier of government recognized by her Constitution that can be entrusted with the funds and authority for this task. Thus in so far as supply is concerned, the involvement of Village Councils is crucial.

Where demand is concerned, the case of Gandhigram shows how the role of a Water User Association can be appropriated by the Village Council itself. The possibility of the Water User Association and the Village Council working at cross-purposes cannot be ruled out and has been known to happen. But as Upadhyay (2005) points out these incidents are largely due to Government Departments privileging Water User Associations which are registered societies over the Village Council which is a constitutional body on matters where the latter has legitimate interests. Now the stated policy in India as enunciated by the Union Cabinet of Ministers is that local schemes regarding water management will be routed through the Panchayats and Water User Associations will have to work with the Panchayats. This arguably is merely linking Power with responsibility where the Panchayats are concerned.

However, democratic decentralization is not the only variable that affects ground water extraction. The rest of the paper discusses the other factors and models that affect water extraction.

Determinants of ground water extraction: A regression analysis :

In spite of the practical problem associated with direct observation over the ground water exploitation, it is not inconceivable to control exploitation by indirect measures. If we know the causes of exploitation we can explain how to control extraction accordingly with the policy variables concerned. Policies like ban of rice production in water scarce area, and encouraging alternative policies like dry farming, poultry farming, cattle farming etc., can be suggested. For this purpose, we set up a regression model in the next section.

A number of factors, though finite, are responsible for ground water extraction. They are generally classified broadly into four.

1. Growth factors – Population and GDP
2. Production Structure – Share of Agriculture and Forestry
3. Property Rights – Pricing System

4. Govt. Policies – Taxes and Subsidies

To this we add a fifth, the existence of experienced PRIs in the state (as defined by us as having been in existence for the last twenty-five years with regular elections.) It is our intention to see whether the presence of this institution affects ground water depletion.

It is very important to notice that ground water is never priced. Hence indiscriminate ground water exploitation at zero cost due to lack of proper function of pricing system is expected. Movement of ground water towards within and steeper aquifers has posed severe complications for property rights assignment as the whole process remains unnoticed (Blomquist *et al.,* 1994). Due to the absence of property rights or ill-defined property rights, the economic value of the harvested resource is not accrued to the aquifers. Further, ground water extraction by pumping is indirectly encouraged through subsidies for fuel and electricity. Pricing electricity at a flat rate or even supplying it free instead of on a 'volumetric approach' has led to the over exploitation of scarce ground water resources. Rural and urban water charges are much lower than the cost of provision and suffer from poor operation and maintenance. The result in all sectors has been higher consumption and inefficient cost recovery. Other forms of agricultural subsidies also have led to clearing of forests causing free rainfall runoffs[8] directly to the sea and precluding precipitation, percolation, and seepage into ground water aquifers. *The purpose of this study is to see whether PRIs have been able to compensate to any degree for government policies that promote ground water depletion or whether it has been able to internalize the problem of externalities or eliminate the problems of free-riding.*

The empirical model: A panel study :

Considering interstate primary and secondary data for the Indian economy, our interest is to see how interstate differences (which includes PRIs) in extraction are responsible for depletion of ground water. For this exercise, the use of multiple regression analysis under single equation regression models is of immense interest. Panel data analysis will be performed as the regression study is on across states over the years.

Methodology is very much similar to the one used in '*Estimating water use in the US: A new paradigm for the national water use information program, Committee on USGS Water Resources Research,* National Research Council (NRC), 2002'. A substantial body of work on model structure and estimation methods were performed by NRC team. In the paper, public water supply including both ground water and surface water is modeled as a function of a set of explanatory variables such as average price of water, gross state product per capita, precipitation, average temperature, dummy 1 for states with ground water rights and dummy 2 for states with surface water rights. The size and signs of the estimated regression coefficients fell within the ranges of expected values (NRC, 2002).

For the purpose of the study of local condition of Indian states, inclusion and exclusion of appropriate variables are accordingly done. Depending on the purpose for which the estimates are used, the dependent variable (*i.e.*, ground water extraction or withdrawal) can be presented in different ways. For example, in studies of surface and groundwater resources,

8. In Gujarat (Bhatia 1992).

the data are usually available as yearly withdrawals at a point such as a river intake or a well. Because the water withdrawn is typically used (or applied) over a larger land area, an equivalent hydrologic definition of water use would be the use of water over a defined geographical area (e.g., an urban area, a county, or a state). Total water use within a larger geographical area such as a country or state can be presented as a sum of water use by several groups of users within a number of sub areas.

Generally, water use at any level of aggregation can be modeled as a function of one or more explanatory variables.

$$E_{it} = a_0 + \sum_{i=1}^{n} b_j x_{it}^j + e_{it}$$

where, E_{it} represents extraction within geographical area *i* during year *t,* x_{ij}^j is a set of *j* explanatory variables within geographical area *i* during year *t,* which are expected to explain variation in extraction, and e_{it} is the random error term. The coefficients a_0 and b_j can be estimated by fitting a multiple regression model to the historical data.

Model estimation:

An estimate of groundwater withdrawals for any state and year can be made using the model (1). The variables are chosen in a way that the government can bring in policy implications accordingly with the results. As yet, extraction as a function of variables like rainfall, temperature, precipitation, evaporation, permeability, geologic structures and etc, are considered to be exogenous and hence are not included in the model.

NRC's model considers total water supply including both ground water and surface water. Fortunately, there exists an efficient property right system for both the sources of water supply and the federal system is the sole supplier of water[9] . Hence it is modeled as a function of mainly average price and gross state product per capita. But in case of India, due to the absence of efficient property rights (ill-defined) system, the ground water management enforceability of the government (sole owner) is not effective and hence ground water is underpriced (often price is zero). For these reasons, we are interested to check in the true conditions (local) which would explain ground water extraction in India. Following, we model our dependent variable as:

$$E_{it} = a_0 + \sum_{i=1}^{5} b_j x_{it}^j + e_{it}$$

or

$$E_{it} = a_0 + b_1 Agri_{it} + b_2 CanalIR_{it} + b_3 Subsidies_{it} + b_4 Forest_{it} + b_5 Pop_{it} + e_{it}$$

where,

9. However, in the western U.S. surface allocations are relatively well-defined (though adjudications still bring up many issues) and groundwater rights are partially defined. Some states, such as Colorado, have relatively well-defined and technically well-analyzed allocations for groundwater, at least in areas where it has become a subject of dispute. In other states, such as California, groundwater allocation is incomplete in important ways, subject to different principles. Also, Bureau of Reclamation is a major supplier, but much supply is also handled by cities, irrigation districts, state agencies and other entities (We thank the referees for pointing these interesting points).

E_{it}	Ground Water Extraction or Withdrawal in Million Cubic Meters (MCM) in state i during t
$Agri_{it}$	Share of Agricultural product in State Domestic Product (SDP) in state i during t at 1993-94 prices
Canal IR_{it}	Area Irrigated by Canal Irrigation in State i during t
$Subsidies_{it}$	State Agricultural Subsidies in i state during t
$Forest_{it}$	Actual Forest Area in Square Km in State i during t
Pop_{it}	Population Density in State i during t

Sources of information and data:

For the purpose of modeling, we explore the structure of the past Central Ground water Board (CGWB) state-level aggregated groundwater use data, based on corresponding (and routinely collected) demographic, economic, and climatic data. The purpose of this inquiry is to determine if multiple regression models have the potential to explain the temporal and geographic variability across India of the aggregated groundwater use estimates produced by the CGWB. According to the availability of data on all the required variables 14 states (Table 1) have been chosen for the years 1988, 1992, 1996 and 2000 with 4 years internal gap.

Table 1 : States for the Model

Sr. No.	States
1.	Andhra Pradesh
2.	Bihar
3.	Gujarat
4.	Haryana
5.	Karnataka
6.	Kerala
7.	Madhya Pradesh
8.	Maharashtra
9.	Orissa
10.	Punjab
11.	Rajastan
12.	Tamil Nadu
13.	Uttar Pradesh
14.	West Bengal

Regression Estimates and Analysis of Results :

What is expected from Regression? :

Ground water extraction is mainly due to agriculture. Gross area irrigated by tube wells, dug wells and other wells over the years has increased in most of the states. Irrigation accounts for nearly 90% of total extraction. The water level in several parts of the country has been falling rapidly due to the indiscriminate increase in wells drilled for irrigation of both food and commercial crops. Advent of "Green Revolution" had also led to the depletion of ground water. To put it straight, green revolution is rather due to ground water. With the use

Table 2 : Data source of the structural variables

Variables	Components	1988-89	1992-93	1996-97	2000-01
Extraction	Gross Draft in MCM (Irrigation+Domestic+Industrial)	1988-89	1992-93	1996-97	2000-01
Source: Ground Water Statiatics, CGWB, Ministry of Water Resources, Faridabad					
Agriculture	Agri/SDP in 1993-94 Prices (in Rs Lacs)	1988-89	1992-93	1996-97	2000-01
Source: Statistical Abstract of India					
Canal irrigation	Area Irrigated in Hectares	1988-89	1992-93	1996-97	2000-01
Source: Statistical Abstract of India					
Subsidies	Fertilizer+ Power+ Irrigation (in Rs. Crores)	1988-89	1992-93	1995-96	Extrapolated
Source: Acharya, S.S. (2000), 'Subsidies in Indian Agriculture and their Beneficiaries', Agricultural Situation in India, Volume LVII, August, Number 5, pp 251-260 (Library, Directorate of Economics & Statistics, Ministry of Agriculture)					
Forest Cover	Area in Sq.Km	1989	1993	1997	1999
Source: State of Forest Report 2001, Forest Survey of India, Ministry of Environment and Forest					
Population Density	Popolation per Sq.Km	1998	1992	1996	2000
Source: Statistical Abstract of India					

of HYV seeds and fertilizer all the more water is required for the maturity of crops. Green revolution was characterized by land-saving but water-using technologies whereas dry land areas needed water-saving enterprise and practices which optimize output per unit of scarce water. In the absence of such technologies, the farmers in the dry land areas go in for water-intensive crops like rice when water resources are conserved giving rise to conflicts on water and scarcity of drinking water. The rapid increase in the agro-chemical use in the past 5 decades has contributed significantly to the pollution of ground water[10] . This has resulted in the contamination of ground water. Hence water resources have been rendered unsafe for human consumption as well as for other activities such as irrigation and industrial needs. This illustrates that degraded water quality can in effect contribute to water scarcity as it limits its availability for both human use and the eco-systems, Further it exacerbates the extraction which is an instant cause of increased demand out of scarcity. By nature, canal water is near substitute to ground water and more the area irrigated by canal water, lesser the ground water extraction. However, it cannot be ignored that the unreliability of canal water leads to investment in groundwater, even in places with access to canal water. Subsidies which have been under consideration are specifically agricultural subsidies. They constitute a sum of irrigation, fertilizer and electricity subsidies. They are basically input subsidies. For

10. Usage of agro-chemicals rose from less than 1 million tones in 1948 to a maximum of 75 million tones in 1990 (CSE, 1999).

instance, provision of free electricity or even charging at a flat rate has been a state policy in most of the states. More the subsidy more is the extraction[11]. Before expecting the sign of the forest coefficient, we would want to distinguish between national and plantation forests. Generally, forests help recharging the ground water aquifers (UNEP, 2009). In the absence of plant cover, the run-off rate is accelerated[12] . In Gujarat, denudation has played an important role in accelerating run-off and reducing ground water recharge. Just as denudation is a cause of increasing water scarcity, the disruption of the hydrological cycle itself contributes to the disappearance of forests. The latter problem should be a cause of deep concern in its own right (Bhatia, 1992). An increased forest cover would support higher recharge resulting in an increase in the water tables. Increased water table is associated with low cost of extraction. Hence forest cover and extraction are expected to move together. Further, in an effort to keep the environmental balance, most of the state governments have resorted to protect the forest areas and plantation of forest (afforestation), maintenance of zoo, etc., are all of immediate concern which would require lots of watering leading to extraction. Population density has strong impact on increased water demand over the years. Population has been rapidly increasing over the years which has increased the demand for water making the per capita availability of water per year to decline rapidly, and projected per capita availability for 2025 alarms the 'WATER STRESS' as it falls below 1700 cubic meters per year (Seckler 1999).

Analysis of Results :

Hausman Specification Test:

Test: Ho = Difference in Coefficients Not Systematic

$$^{2}_{k} = [b - \beta]'[\mathrm{Var}(b) - \mathrm{Var}(\beta)]^{-1}[b - \beta]$$

= 23.51

p values = 0.0003

Breusch and Pagan Lagrangian Multiplier Test for Random Effects:

Extraction[state,t] = Xb + u[state] + e[state,t]

Test: Var(u) = 0

$^{2}_{1} = 35.62$

p values = 0.000

11. The causation may also run the other way; the more subsidized the users, the greater their political power to lobby for keeping or increasing subsidies. However, we are interested in the behavioral patterns of water extraction when such subsidies are given. More over water extraction is dynamic, whereas subsidies are discrete in nature. An announcement of subsidy at a point of time causes dynamic changes in extraction over time (We thank the referees for this insightful comment).

12. There are some major myths and debates about the relationship between forest and groundwater, especially in relation to reforestation. In general, removal of existing natural forest tends to increase runoff, however trees transpire, and many species, e.g. pines, used for reforestation do not encourage infiltration. However, these debates are subjective to type of plantation and hence require empirical testing (We thank the referees for this insightful comment).

Table 3 : Fixed effects vs random effects

Method	Fixed effect			Random effect		
Variables	Coefficients	t	P>ItI	Coefficients	z	P>ItI
Constant	-24024.95	-3.59	0.001	173.5732	0.03	0.973
Agriculture	4958.95	1.29	0.205	5438.728	1.04	0.296
Canal IR	-0.1135907	-0.13	0.899	2.272487	1.98	0.047
Subsidies	1.31742	4.36	0.000	1.286212	3.14	0.002
Forest Cover	1.035361	5.19	0.000	0.1248539	1.86	0.063
Pop Density	14.41316	2.92	0.006	16.4506	2.74	0.006
	R-Sq:	Within	0.6917	R-Sq:	Within	0.4908
		Between	0.0260		Between	0.3605
		Overall	0.0271		Overall	0.3599
	F(5,37)	16.61		Wald Chi-Sq	38.39	
	P>F	0.000		P > Chi-Sq	0.00	
	Corr(Ui, Xb)	-0.937		Corr(Ui, X)	0.00	
				RE Ui	Gaussian	
	Sigma u	33964.74		Sigma u	5638.169	
	sigma e	1143.307		sigma e	1143.307	
	rho	0.998868		rho	0.960504	
Residuals statistics	Minimum	Maximum	Mean	Std. Deviation	Observations	Groups
Predicted value	477.6821	54,263.31	16,511.52	11,694.95	56	14
Residual	-2,065.03	2,455.62	0	937.73995	56	14
Std. Predicted value	-1.371	3.228	0	1	56	14
Std. Residual	-1.806	2.148	0	0.82	56	14

· Based on Hausman specification test, we obtain the test statistic of 23.51, which far exceeds the 95 % critical value for Chi – Squared with 5 degrees of freedom, 1.145476.

· Based on least squares residuals, we obtain Lagrange Multiplier test statistic of 35.62, which far exceeds the 95 % critical value for Chi – Squared with 1 degree of freedom, 0.00393.

At this point, from both the tests, we conclude that the classical regression model with a single constant term is inappropriate for these data. The result of the tests in both the cases is to reject the null hypothesis in favour of random effects model.

Analysis of Results: Fixed Effects Model :

The size and signs of the estimated regression coefficients fall within the range of expected values. These coefficients can be interpreted to mean that across India (14 states), from 1988-2000, the mean withdrawal was 16511.52 Million Cubic Meters (MCM) from the data. This average withdrawal would -

· Increase by 4958.95 MCM if the share of agriculture in SDP were increased by Rs. 1 Lac/SDP ($2000/SDP), however, the figures are statistically insignificant (20.5%) and hence are only indicative.

· Decrease by 0.1135907 MCM if the area irrigated by canal water were increased by 1000 hectares and the figures are statistically insignificant (89.9%) and hence are only indicative.

- Increase by 1.31742 MCM if subsidies were increased by Rs. 1 Crore ($0.2 Million) and the figures are statistically significant at 1%.
- Increase by 1.035361 MCM if forest Cover were increased by 1 Square Kilometer and the figures are statistically significant at 1%.
- Increase by 14.41316 MCM if population densities were increased by 1 per Square Kilometer and the figures are statistically significant at 1%.

Least Squares Dummy variable (LSDV) Model: Some Evidence to the Effectiveness of the PRIs :

The predictions from the model in Table 3 can be improved by supplementing them with information that is contained in model residuals (*i.e.*, differences between actual and predicted values). This can be done by introducing binary variables, which designate individual states. In a model with binary state indicator variables, the average value of residuals for each state is added to the predicted value for that state thus reducing the prediction error. Similarly, if the state residuals contain an increasing or decreasing time trend, such a state-specific trend can also be added to the prediction. However, the addition of separate intercepts does increase the number of model parameters. If the resulting model is over-specified, the coefficients of the continuous variables, which form the structural component of the model, may be biased. Such bias is small when the inclusion of a state-specific intercept does not result in an appreciable change in the value of the estimated coefficients of the structural variables *i.e.*, x^j_{it}.

$$E_{it} = a_0 + \sum_{i=1}^{12} a_i D_i + \sum_{i=1}^{5} b_j x_{it}^j + c_i PRI_i + e_{it} \quad (3)$$

or

$$E_{it} = a_0 + a_1 D_1 + a_2 D_2 + a_3 D_3 + a_4 D_4 + a_5 D_5 + \ldots\ldots\ldots + a_{11} D_{11} + a_{12} D_{12}$$

$$+ b_1 Agri_{it} + b_2 CanalIR_{it} + b_3 Subsidies_{it} + b_4 Forest_{it} + b_5 Pop_{it} + c_i PRI_i + e_{it}$$

Usually referred to as ‘Least Squares Dummy variable’ (LSDV) Model. But what of the impact of PRIs when it comes to water extraction in the various Indian states? Here we have introduced one more dummy for democratic decentralization which takes the value of 1 if the state has a sustained tradition of PRIs operating in it and 0 if the state has not had this experience. Gujarat, Maharashtra, West Bengal and Kerala have long had a traditional of holding regular elections to the PRIs even before the passage of the 73rd Constitutional Amendment that required all Indian States (except the state of Jammu and Kashmir) to do so. But many states have been tardy in the implementation of this amendment. Hence we have assigned Gujarat, Maharashtra, West Bengal and Kerala 1 and 0 for the rest of the states. It may be mentioned that all four states have been affected by a precipitous drop in groundwater levels. A cursory look at these four states reveals that Kerala and West Bengal have very high population densities while large parts of Gujarat and Maharashtra experience very little precipitation.

However, local politics in all these four states has centered around the local bodies and therefore farmers whose involvement is necessary for the success for any scheme relating to water, are already politically aware and glued to local level leadership. Indeed, in Kerala and West Bengal, Panchayati Raj Institutions were introduced and empowered by Leftist Governments precisely to empower political activists belonging to the ruling Communist Party of India (Marxist) and allied parties at the expense of the bureaucracy whose loyalty was seen to lie with the (often hostile) Central Government (Ghosh *et al* 2003). Similarly, local bodies were empowered in Maharashtra by T.B. Chavan in his tenure as Chief Minister because he wanted an orderly shift of power to intermediate castes without unduly disturbing the dominance of the upper castes at the state level. Empowerment of the intermediate castes at the local levels and then empowering the bodies themselves was the best way to share power without undue dislocation of the existing power structure. The Panchayati Raj movement was founded in Gujarat, the very State that Mahatma Gandhi (who was the strongest votary of *Gram Swaraj/* Village Self Rule) came from. Indeed the movement towards the three-tier Panchayati Raj in India is based on the recommendations of the Committee headed by Balwant Rai Mehta, the second Chief Minister of the State. Given the patronage that the governments of these states day gave the local bodies it is to be expected that local level leaders were empowered and thus experienced in the art of governance. In contrast to the rest of the country, where a formal three-tier structure of representative local self government is a post 1992 phenomenon (after the enactment of the 73rd Amendment to the Constitution), these four states had a far longer experience with the state of West Bengal being the last of these to introduce Panchayati Raj in 1978. Therefore it is clear that when looking at the impact of PRIs on governance, steps must be taken to ensure that the experience of these four states are given due weight.

In this context, a dummy of 1 if the states concerned are one of these four states or 0 otherwise. We expect the sign of the PRI coefficient to be negative. A negative extraction would mean a lower extraction or controlled extraction or lower misuse and/or a higher recharge.

Further, if a qualitative variable has *m* categories, introduce only *m-1* dummies to avoid Dummy Variable Trap (DVT), that is, the situation of perfect collinearity or perfect multicollinearity, if there is more than one exact relationship among the variables. In our case we have 4 (*i.e.*, 2x2) categories of 2 of the qualitative variables:

PRI dummy	= 1	PRI state
	= 0	Non-PRI State and
State Dummy	= 1	State included
	= 0	State not included

and hence we have dropped West Bengal from PRI group for PRI Dummy[13] and Uttar Pradesh from Non-PRI group as State Dummy[14] (Table 4). The category for which no dummy variable is assigned is known as the base, benchmark, control, comparison, reference, or omitted category. And all the comparisons are made in relation to the benchmark category. Since we have dropped West Bengal for PRI dummy and Uttar Pradesh for state dummy,

14. There are 4 PRI states and hence we introduce 4-1 dummies.
15. There are 14 states and hence we introduce 14-1 dummies. Here we have chosen Uttar Pradesh to represent the benchmark category for it reflects the status of Non-PRI states

the coefficient attached to PRI dummy represents the mean value of the benchmark category *i.e.*, West Bengal and the coefficient attached to State dummy represents the mean value of the benchmark category *i.e.*, Uttar Pradesh. And hence:

i. The coefficient attached to PRI dummy is known as the differential intercept coefficient as it quantifies by how much the value of the other PRI states receive the value of 1 differs from the intercept coefficient of the benchmark state, *i.e.*, West Bengal.

ii. Similarly, The coefficient attached to State dummy is also known as the differential intercept coefficient as it quantifies by how much the value of the other Non-PRI states receive the value of 1 differs from the intercept coefficient of the benchmark state *i.e.*, Uttar Pradesh.

Table 4 : States with corresponding dummies

Sr. No.	States
D1	Andhra Pradesh
D2	Bihar
D3	Gujarat
D4	Haryana
D5	Karnataka
D6	Kerala
D7	Madhya Pradesh
D8	Maharashtra
D9	Orissa
D10	Punjab
D11	Rajastan
D12	Tamil Nadu
Constant	Mean Value of Uttar Pradesh
PRI	Mean value of West Bengal

These above (i) and (ii) constructs can be shown mathematically as follow:

When everything else is zero, the intercept term for;

i^{th} State which is a Non-PRI but with a state dummy is: a_0+a_i

i^{th} State which is a PRI and with a state dummy is: $a_0+a_i+c_i$

i^{th} State which is an excluded Non-PRI from the model: a_0

i^{th} State which is an excluded PRI from the model: c_i

PRI Dummy :

As expected the sign of the PRI coefficient is negative and the value of *t* is 2.838 which is statistically significant at 1% confidence interval[1] . This coefficient can be interpreted to mean that across India (14 states), from 1988-2000, the mean withdrawal was 16511.52 Million Cubic Meters (MCM) from the data and this;

i. Average withdrawal has decreased by 15940.412 MCM among all the 4 PRI states. However, individual PRI states have shown different figures compared to the benchmark state *i.e.*, West Bengal. Compared to West Bengal,

a. Kerala has shown a decline in withdrawals by 3649.365 MCM and the figures are

Table 5: The Summary of the LSDV Estimation

Model 1	Depedent Variable: Extraction of Ground Water	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	Agri	4,958.95	3,847.49	0.046	1.289	0.205
	Canal IR	-0.114	0.887	-0.007	-0.128	0.899
	Subsidies	1.317	0.302	0.125	4.362	0
	Forest	1.035	0.199	2.896	5.192	0
	Pop	14.413	4.942	0.254	2.916	0.006
	Andhra Pradesh	-41,601.37	3,460.79	-0.921	-12.021	0
	Bihar	-26,542.19	2,406.28	-0.588	-11.03	0
	Gujarat	3,469.10	1,696.32	0.154	2.045	0.048
	Haryana	-3,336.10	6,590.46	-0.074	-0.506	0.616
	Karnataka	-35,260.75	2,705.18	-0.781	-13.035	0
	Kerala	-3,649.37	592.505	-0.162	-6.159	0
	Madhya Pradesh	-128,590.04	20,407.74	-2.848	-6.301	0
	Maharashtra	-10,686.19	4,110.41	-0.473	-2.6	0.013
	Orissa	-51,450.70	4,206.37	-1.14	-12.232	0
	Punjab	9,249.14	6,398.14	0.205	1.446	0.157
	Rajasthan	-11,693.75	4,580.10	-0.259	-2.553	0.015
	Tamil Nadu	-7,153.20	3,926.68	-0.158	-1.822	0.077
	Constant (Mean Value of Uttar Pradesh)	19,192.15	12,838.71	-	1.495	0.143
	PRI (Mean value of West Bengal)	-15,940.41	5,617.03	-0.619	-2.838	0.007

statistically significant at 1%.

b. Maharashtra has shown a decline in withdrawals by 10686.194 MCM and the figures are statistically significant at 5%.

c. Gujarat has shown an increase in withdrawals by 3469.1 MCM and the figures are statistically significant at 5%.

State Dummy :

The sign of the State Dummy coefficient is positive and the value of *t* is 1.495 which is statistically significant at 14.3% confidence interval (away from conventional statistical significance level by 4.3%). This coefficient can be interpreted[2] to mean that across India (14 states), from 1988-2000, the mean withdrawal was 16511.52 Million Cubic Meters (MCM) from the data and this;

ii. Average withdrawal has increased by 19192.15 MCM among all the Non-PRI states. However, individual Non-PRI states have shown different figures compared to the benchmark state *i.e.*, Uttar Pradesh. Compared to Uttar Pradesh,

a. Andhra Pradesh has shown a decline in withdrawals by 41601.374 MCM and the figures are statistically significant at 1%.

b. Bihar has shown a decline in withdrawals by 26542.193 MCM and the figures are statistically significant at 1%.

c. Haryana has shown a decline in withdrawals by 3336.103 MCM and the figures are statistically insignificant (61.6%).

d. Karnataka has shown a decline in withdrawals by 35260.753 MCM and the figures are statistically significant at 1%.

e. Madhya Pradesh has shown a decline in withdrawals by 128590.037 MCM and the figures are statistically significant at 1%.

f. Orissa has shown a decline in withdrawals by 51450.703 MCM and the figures are statistically significant at 1%.

g. Punjab has shown an increase in withdrawals by 9249.143 MCM and the figures are statistically insignificant (15.7%).

h. Rajasthan has shown a decline in withdrawals by 11693.746 MCM and the figures are statistically significant at 5%.

i. Tamil Nadu has shown a decline in withdrawals by 7153.203 MCM and the figures are statistically significant at 5%.

Bias is small or even zero in this case as the LSDV model has not resulted in an appreciable change in the value of the estimated coefficients of the structural variables *vis-à-vis* Agriculture, Canal Irrigation, Subsidies, Forest Cover and Population Density.

Conclusions and Policy Suggestions

Conclusion:

An important ground water management enforceability issue is how to evaluate current versus future use of ground water. Unfortunately, states rarely consider future ground water uses in ground water management policies dealing with ground water depletion. The states that do have explicit policies to limit ground water depletion, ineffectively regulate current ground water uses to extend aquifer life. There is unfortunately too little attention given to regulating existing ground water uses to lengthen aquifer life, let alone any explicit quantitative evaluation of the trade-off between current and future ground water use. Consequently, ground water valuation has historically played almost no role in state ground water management policies. Ground water policies in most states could be strengthened by acknowledging ground water's future value.

Here democratic decentralization especially in the form of empowered PRIs can alleviate a problem caused by unwise government policies and the state of the undefined nature of property rights when it comes to common property resources like ground water. These institutions have the potential of internalizing externalities and thus arriving at a more optimal solution regarding ground water usage. Indeed even investments to augment water supply/ stock may be undertaken as the free-rider problem is also simultaneously tackled.

In the absence of empowered PRIs, certain facts come painfully to light, *viz* that no one owns ground water due to ill – defined property rights, too many extractors (heterogeneous users), controlling harvesting is practically not possible. In spite of the practical problem associated with direct observation over the ground water exploitation, it is not inconceivable to control exploitation by indirect measures. We, from a broad literature survey, have found a set of factors determining the ground water extraction such as SDP, population, urbanization, forest cover, subsidies and most importantly for this study PRIs etc. Juxtaposing all these factors, we have set up a regression model which would explain the variation in extraction by a set of 5 policy variables as well as the institutional variable *i.e.*, PRI. The model is tested using interstate analysis of the Indian Economy for the period of 1980 – 2000. Since the model constitutes pooled (Time Series and Cross Section) data across states over the years, Panel Regression Analysis has been performed. From this exercise we found that forest, subsidies and population density appearing as key factors in explaining the ground water extraction. On the basis of these findings we thus suggest in this paper certain indirect policy measures for sustainability of ground water. But we have also demonstrated that states with empowered PRIs also do well from the point of view of sustainability.

Policy Suggestions:

From this exercise we found that forest, subsidies and population density as well democratic decentralization appearing as key factors in explaining the ground water extraction. With respect to forest, nothing other than protecting existing forests is to be suggested. Effective direct and indirect measures of population control programs should be implemented keeping well in mind that the per capita availability of water and alarming 'WATER STRESS'.

Proper crop management policy is required. Water intensive crop should be encouraged to cultivate in water abundant states and districts within states. Production planning should be on the basis of 'Comparative Advantage'.

Dealing with subsidies requires special attention, as it also invokes the global market in terms of Agreement on Agriculture (AOA) under World Trade Organization (WTO) norms. Government's recent procurement price policy, indiscriminant subsidies and other likely mechanisms have resulted in higher extraction of ground water in states like Punjab, Haryana and Uttar Pradesh and where the water problem is acute.

Government should discriminate between states encouraging those states with subsidies to grow water intensive crops where water is abundant and discourage where water is scarce. Encouraging dry farming in water scarce states via subsidies may help to explain what form such subsidies could take. Understanding the necessity of water, agricultural production, rural base, etc, in a developing country like India, we would argue that we are not against subsidies scheme. Prioritizing and supporting the production of state specific crops according to availability of water (comparative advantage), and yet resulting inter and intra-regional trade would help states gain and hence consequent achievement of self-sufficiency, and sustainable development of ground water resources.

But the main contention of this study, that democratic decentralization leads to more sustainable policies and thus Indian states must implement the 73rd Constitutional Amendment in its true spirit is also bourne out. Empowered Panchayats promote participatory decision making and implementation. Such bodies have the kind of relevant information as well as the social resources to reduce the free-rider problem so endemic in common property resources. Thus the central government should encourage those states which empower their panchayats with financial resources and powers with matching grants tied to micro-irrigation projects.

1. State intercept terms change as one changes the benchmark (omitted) states. However, the PRI coefficient is stably negative and statistically significant irrespective of the choice of benchmark states.

2. These interpretations are only indicative of the status of ground water withdrawals among Non-PRI states. Hence, policy recommendations stand weak as the State Dummy coefficient is away from conventional statistical significance level by 4.3%.

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